

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A system for processing a workpiece, comprising:

(A) a plasma immersion ion implantation reactor, comprising:

(1) an enclosure comprising a side wall and a ceiling and defining a chamber;

(2) a workpiece support pedestal within the chamber having a workpiece support surface facing said ceiling and defining a process region extending generally across said wafer support pedestal and confined laterally by said side wall and axially between said workpiece support pedestal and said ceiling;

(3) said enclosure having at least a first pair of openings at generally opposite sides of said process region;

(4) a first hollow conduit outside of said chamber having first and second ends connected to respective ones of said first pair of openings, so as to provide a first reentrant path extending through said conduit and across said process region;

(5) gas distribution apparatus on or near an interior surface of said reactor for introducing a process gas containing a first species to be ion implanted into a surface layer of said workpiece;

(6) a first RF plasma source power applicator for

generating a plasma in said chamber;

(B) a second wafer processing apparatus;

(C) wafer transfer apparatus for transferring said workpiece between said plasma immersion ion implantation reactor and said second wafer processing apparatus;

wherein said workpiece support pedestal of said plasma immersion ion implantation reactor comprises:

a conductive wafer support plate;

a grounded conductive base plate forming at least a void between said support and base plates;

a side wall around said support and base plates forming at least a void between said side wall and said support and base plates;

a high dielectric filler material having a high breakdown voltage filling said voids; and

a conductive insert coupled to said bias power generator and a conductive female receptacle for tightly receiving said conductive insert, said conductive female receptacle being connected to said conductive wafer support plate, said conductive insert and said conductive female receptacle extending through said conductive base plate to said conductive wafer support plate, and insulating layer insulating said conductive insert from said conductive base plate.

Claim 2 (original): The system of Claim 1 wherein said second wafer processing apparatus comprises a cleaning species source plasma reactor comprising:

- (1) a source of cleaning species precursor gases;
- (2) a passage coupling said cleaning species source plasma reactor to said plasma immersion ion implantation reactor.

Claim 3 (original): The system of Claim 2 wherein said cleaning species precursor gases comprise a fluorine-containing species.

Claim 4 (original): The system of Claim 2 wherein said cleaning species precursor gases comprise a hydrogen-containing species.

Claim 5 (original): The system of Claim 1 wherein said second wafer processing apparatus comprises:

an optical metrology chamber for obtaining a measurement of ion implantation in a workpiece;

a process controller coupled to receive measurements from said optical metrology chamber for controlling said plasma immersion ion implantation reactor.

Claim 6 (previously presented): The system of Claim 1 wherein said second wafer processing apparatus comprises:

an ion beam implantation apparatus for ion implanting a second species into said surface layer of said workpiece.

Claim 7 (previously presented): The system of Claim 6 wherein said surface layer is a semiconductor material, and said first and second species are dopant impurities of opposite conductivity types relative to said semiconductor material.

Claim 8 (previously presented): The system of Claim 1 wherein said second wafer processing apparatus comprises:

a second plasma immersion ion implantation reactor for ion implanting a second species into said surface layer of said

workpiece.

Claim 9 (previously presented): The system of Claim 8 wherein said surface layer is a semiconductor material, and said first and second species are dopant impurities of opposite conductivity types relative to said semiconductor material.

Claim 10 (original): The system of Claim 1 wherein said second wafer processing apparatus comprises an anneal chamber.

Claim 11 (original): The system of Claim 1 wherein said second wafer processing apparatus comprises:
a photoresist strip chamber.

Claim 12 (original): The system of Claim 1 wherein said second wafer processing apparatus comprises a wet clean chamber.

Claim 13 (original): The reactor of Claim 1 wherein said plasma comprises a plasma current in said reentrant path that oscillates at an RF frequency of said first RF plasma source power applicator.

Claim 14 (original): The reactor of Claim 1 wherein said first hollow conduit comprises a metal material, said reactor further comprising:

an annular insulating gap in said first hollow conduit separating said first hollow conduit into axial sections.

Claim 15 (original): The reactor of Claim 1 wherein said ceiling comprises a constriction of said reentrant toroidal path in said process zone for enhancement of plasma ion density of

said plasma current in said process zone.

Claim 16 (original): The reactor of Claim 1 wherein said ceiling and said wafer support pedestal are separated by a gap therebetween, said gap being sufficiently small so that plasma ion density of said plasma current is greater in the vicinity of said workpiece support pedestal than elsewhere along said reentrant path.

Claim 17 (original): The reactor of Claim 1 wherein the workpiece support pedestal comprises an electrostatic chuck, said electrostatic chuck comprising thermal control apparatus for workpiece temperature control.

Claim 18 (original): The system of Claim 1 further comprising a bias source coupled to said workpiece support.

Claim 19 (original): The reactor of Claim 18 wherein said bias source comprises an RF bias generator having an RF bias frequency sufficiently low to enable ions traversing the plasma sheath to attain an energy corresponding to a peak-to-peak voltage of said bias power generator.

Claim 20 (original): The reactor of Claim 19 wherein said RF bias frequency is sufficiently high to limit RF voltage drops across dielectric layers on said workpiece support pedestal to less than a predetermined fraction of plasma sheath voltage near said workpiece support.

Claim 21 (original): The reactor of Claim 20 wherein said predetermined fraction corresponds to about 10%.

Claim 22 (currently amended): A system for processing a workpiece comprising a plurality of plasma immersion ion implantation reactors, each of said plasma immersion ion implantation reactors comprising:

(1) an enclosure comprising a side wall and a ceiling and defining a chamber;

(2) a workpiece support pedestal within the chamber having a workpiece support surface facing said ceiling and defining a process region extending generally across said wafer support pedestal and confined laterally by said side wall and axially between said workpiece support pedestal and said ceiling;

(3) said enclosure having at least a first pair of openings at generally opposite sides of said process region;

(4) a first hollow conduit outside of said chamber having first and second ends connected to respective ones of said first pair of openings, so as to provide a first reentrant path extending through said conduit and across said process region;

(5) gas distribution apparatus on or near an interior surface of said reactor for introducing a process gas containing a first species to be ion implanted into a surface layer of said workpiece;

(6) a first RF plasma source power applicator for generating a plasma in said chamber;

wherein said workpiece support pedestal of said plasma immersion ion implantation reactor comprises:

a conductive wafer support plate;

a grounded conductive base plate forming at least a void between said support and base plates;

a side wall around said support and base plates forming

at least a void between said side wall and said support and base plates;

a high dielectric filler material having a high breakdown voltage filling said voids; and

a conductive insert coupled to said bias power generator and a conductive female receptacle for tightly receiving said conductive insert, said conductive female receptacle being connected to said conductive wafer support plate, said conductive insert and said conductive female receptacle extending through said conductive base plate to said conductive wafer support plate, and insulating layer insulating said conductive insert from said conductive base plate.

Claim 23 (original): The system of Claim 22 further comprising a wafer handling apparatus coupled to each of said plurality of plasma immersion ion implantation reactors.

Claim 24 (new): The system of Claim 1 wherein said workpiece support pedestal further comprises at least one lift pin assembly extending through said conductive base plate and said conductive wafer support plate and a axial void between said lift pin assembly and said lift pin assembly, and a high dielectric filler material having a high breakdown voltage within the void between said lift pin assembly and said conductive wafer support plate.

Claim 25 (new): The system of Claim 24 further comprising a fastening bolt extending at least partially through said conductive wafer support plate and to said conductive base plate, and a high dielectric filler material having a high breakdown voltage surrounding a portion of said bolt within said conductive